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Editor Analyst:

Since the publication of the article on the Solution of Equations in the last ANALYST, I think I have discovered "the weak link in the chain" of its logic, as applied to the solution of the equation of the 5th degree.

It lies in the statement, near the bottom of page 5, that in the supplemental equations "one letter may be interchanged with another without disturbing any relations". If, in brief, numerical values be assigned to the letters, an interchange in the order of their arrangement materially disturbs the relations.

Thus if $x = \sqrt[5]{a^5} + \sqrt[5]{b^5} + \sqrt[5]{c^5} + \sqrt[5]{d^5} = 1 + 3 + 5 + 7$, the arrangement of $x = 1 + 3 + 7 + 5$ furnishes, when the substitution is made, a *different* equation from the one first given. As these letters are capable of twenty-four permutations, the result is the production of twenty-four general eq'ns of the 5th degree. But as only one is given for solution, an additional element is unfolded in the eq'n of the 5th degree, namely, a dependence of its solution, not only upon the value of the four letters a, b, c and d , but also upon the *order* of their arrangement. As these letters cannot be thus permuted and satisfy the given equation, it would appear that instead of one final equation being produced by elimination, "whichever three of the four unknown quantities are eliminated", four final equations would be produced, one each in a, b, c and d . It remains to determine by algebraic analysis, if possible, the character of the roots of these final equations, their mutual relations, the effect of permissible permutations, and whether they can be separated into groups, so as to permit of the reduction of the equations to the 4th degree; or, on the other hand, to determine, by algebraic methods within the comprehension of the ordinary algebraist, the impossibility of such reduct.

I regret that pressure of professional labors renders it impossible for me to further prosecute the work at present; but I shall be pleased if, per chance, I shall have contributed my mite towards awakening a renewed interest in the subject, trusting that further research will yet result in the development of a perfect and complete Theory of Equations.

T. S. E. DIXON.

Chicago, Ill., Feb. 13, 1882.

SOLUTION OF 393 BY R. J. ADCOCK.—"Two particles of masses m and m' respectively, are connected by a string passing through a small fixed ring and are held so that the string is horizontal; their distances from the ring being a and a' , they are let go. If ρ and ρ' be the initial radii of curvature of their paths, prove that

$$\frac{m}{\rho} = \frac{m'}{\rho'}, \text{ and } \frac{1}{\rho} + \frac{1}{\rho'} = \frac{1}{a} + \frac{1}{a'}."$$

LET the origin of rectangular coordinates be the fixed point thro' which the string passes, the axis of y vertical and positive downwards, $\sqrt{x^2 + y^2} = r$, $\sqrt{x'^2 + y'^2} = r'$, their distances from the origin at any time t after the motion begins, T = the tension of the string, g = the force of gravity per unit of mass, $\frac{(dx^2 + dy^2)^{\frac{1}{2}}}{dt} = \frac{ds}{dt} = v$, $\frac{(dx'^2 + dy'^2)^{\frac{1}{2}}}{dt} = \frac{ds'}{dt} = v'$, their velocities. Then the sum of the horizontal, and the sum of the vertical components of the forces on m and m' , per unit of mass, are, respectively,

$$\begin{aligned} \frac{d^2x}{dt^2} &= -\frac{Tx}{mr}, & \frac{d^2y}{dt^2} &= -\frac{Ty}{mr} + g, \\ \frac{d^2x'}{dt^2} &= -\frac{Tx'}{m'r'}, & \frac{d^2y'}{dt^2} &= -\frac{Ty'}{m'r'} + g. \end{aligned} \quad \text{Hence,}$$

$$\left\{ \left(\frac{d^2x}{dt^2} \right)^2 + \left(\frac{d^2y}{dt^2} \right)^2 \right\} \div \left\{ \left(\frac{d^2x'}{dt^2} \right)^2 + \left(\frac{d^2y'}{dt^2} + g \right)^2 \right\}$$

$$= \left\{ \left(-\frac{Tx}{mr} \right)^2 + \left(-\frac{Ty}{mr} \right)^2 \right\} \div \left\{ \left(-\frac{Tx'}{m'r'} \right)^2 + \left(-\frac{Ty'}{m'r'} + g \right)^2 \right\}. \quad (1)$$

Since $r + r' = a + a'$, therefore

$$\frac{d^2r}{dt^2} + \frac{d^2r'}{dt^2} = \frac{v^2}{r} - \frac{T}{m} - \frac{dr^2}{r dt^2} + \frac{v'^2}{r'} - \frac{T}{m'} - \frac{dr'^2}{r' dt^2} = 0, \text{ and}$$

$$T = \frac{m m'}{m + m'} \left[g \left(\frac{y}{r} + \frac{y'}{r'} \right) + \frac{v^2}{r} + \frac{v'^2}{r'} - \frac{dr^2}{r dt^2} - \frac{dr'^2}{r' dt^2} \right]. \quad (2)$$

$$\begin{aligned} \text{Since } \frac{1}{\rho} &= \left(\frac{d^2y}{dt^2} \frac{dx}{dt} - \frac{d^2x}{dt^2} \frac{dy}{dt} \right) \div v^3, \quad \frac{1}{\rho'} = \left\{ -\frac{m'y}{(m+m')r} \left[g \left(\frac{y}{r} + \frac{y'}{r'} \right) \right. \right. \\ &+ \left. \frac{v^2}{r} + \frac{v'^2}{r'} - \frac{dr^2}{r dt^2} - \frac{dr'^2}{r' dt^2} \right] \frac{dx}{dt} + \frac{m'x}{(m+m')r} \left[g \left(\frac{y}{r} + \frac{y'}{r'} \right) + \frac{v^2}{r} + \frac{v'^2}{r'} - \frac{dr^2}{r dt^2} - \frac{dr'^2}{r' dt^2} \right] \\ &\quad \times \frac{dy}{dt} \Big\} \div v^3. \end{aligned}$$

When $t = 0$, y and y' each is also zero. Hence by (1) and (2) the initial ratio of the forces, per unit of mass, on m and m' , is unity, and therefore, since the bodies start from rest, the initial ratios, $v \div v' = 1$, $dy \div ds = 1$, $dx \div ds = -y \div r$, $x \div r = 1$, $y \div v^2 = 1 \div 2g$, $y \div y' = 1$, $dr^2 \div ds^2 = dr'^2 \div ds^2 = 0$, and $\frac{1}{\rho} = -\frac{1}{2a} + \frac{3m'}{2(m+m')} \left(\frac{1}{a} + \frac{1}{a'} \right) = \frac{m'}{m+m'} \left(\frac{1}{a} + \frac{1}{a'} \right)$, for its initial val.

In like manner $\frac{1}{\rho'} = \frac{m}{m+m'} \left(\frac{1}{a} + \frac{1}{a'} \right)$. Therefore

$$\frac{m}{\rho} = \frac{m'}{\rho'}, \text{ and } \frac{1}{\rho} + \frac{1}{\rho'} = \frac{1}{a} + \frac{1}{a'}.$$